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A study of these figures reveals at once the vast amount of available food stuff which the cotton crop of Texas alone can furnish to the world.

Cotton seed flour is very rich in protein, the food principle essential to growth and proper repair of the body. From the results of nutritional experiments in which white rats were given diets whose sole source of protein was cotton seed flour, it was found that cotton seed flour furnished not only an adequate protein for normal growth, but that reproduction was possible and on such diets four normal generations of rats have been raised. The protein of cotton seed flour seems unusually efficient. For an ordinary mixed diet the rats are fed about 25 per cent protein. While on cotton seed flour diet normal growth and reproduction is secured by 18 per cent protein. Cotton seed flour is a valuable source of fat in the diet, and in the light of the great shortage of animal fats will prove a most important source of food.

Cotton seed flour contains no starch and is a valuable food for those who are unable to utilize starch, and who are consequently on a starch-free diet.

The nitrogen-free extract is in the form of sugar, gums and resins.

The most abundant ash constituents of cotton seed flour are phosphorous and potassium, both of which are essential to the normal growth of the body.

Prejudice Against Cotton Seed as a Food. Cotton seed flour has been used as a standard article of diet by some people for a number of years, but it has not been used generally by the public owing to the fact that its fitness for food has been questioned because of the ill effects resulting from the feeding of it to cattle and hogs.

Toxicity of Cotton Seed Flour. Careful feeding experiments with cottoi seed flour, covering a long enough period of time, have not been performed with humans to enable us to draw any final conclusions, but a great number of feeding experiments with animals have been made. There is scarcely a state experiment station that has not done work on this subject. All of the reports agree in the value of the use of cotton seed meal as stock

food, but they do not agree as to the amounts to use nor the combination of foods giving the best results. In many of these reports we find evidence of a diet which is unfitted to the needs of the animals and in some cases evidence of possible poisoning as is proven by the death of the animals.

In the last few years a great deal of attention has been directed to the proper balancing of diets both from the standpoint of the proper proportion of the essential food principles, protein, fat, and carbohydrates; and also in respect to other essential food accessories not so well understood, yet apparently very important from the standpoint of proper nutrition. The late work done upon cotton seed meal indicates strongly that the bad results obtained from feedings are not due to a poisonous substance in the meal, but are due to the feeding of a diet lacking some one or more essential to proper nutrition.

December, 1915, we have a report of the work of Rommel and Vedder[1] in the United States Bureau of Animal Industry, in which they say: "The United States uses only part of the cotton seed meal which it produces and one of the reasons which prevents a larger domestic consumption of this by-product of the cotton industry is the danger that sickness and death may follow its use. Cattle fed for more than 90-120 days on a heavy cotton seed meal ration become lame, eyes discharge and often blindness results. Pigs are peculiarly susceptible." The symptoms cited by various experimenters were so similar to the symptoms of beriberi that Rommel and Vedder conducted experiments to compare the effects of feeding polished rice and cotton seed meal. At the time the article was published the pigs had been on the diets 90 days, all were sick with the same symptoms. The conclusions drawn for their report[2] were as follows:

1. Pigs are susceptible to beriberi when fed a vitamine-deficient ration.

2. So-called cotton seed poisoning is a deficiency disease analogous to the disease known as beriberi, if not indeed identical.

3. The cause of the so-called cotton seed poisoning is probably

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[1]Rommel, G. M., and Vedder, E. B., Agric. Research, 1915, V. 489.

[2]Rommel, G. M., and Vedder, E. B., J. Agric. Research, 1915, V. 489.

a deficiency in the ration causing profound changes in the nervous system. The grain with which cotton seed is usually combined is corn and must be balanced to be fed satisfactorily. When corn meal is fed with cotton seed a combination is made of two deficient foods.

October, 1916, a report was published by Wells of the Georgia Agricultural Experiment Station.[3] In this paper Wells says: "Our experiment in feeding cotton seed meal to pigs shows that it is necessary to balance the ration, not so much as to the nutritive ration determined by the amount of fats, carbohydrates and proteins present, but rather as to the so-called accessory food factors." His conclusion is that cotton seed injury is due to inadequate diet.

The same year the nutrition laboratory of the School of Home Economics of the University of Texas published the results of feeding experiments with cotton seed flour on white rats.[4] The result of this work showed conclusively that rats could be grown and that they would reproduce normally to the fourth generation upon diets one-half of which was cotton seed flour, but that rats would neither grow normally nor reproduce upon diets containing cotton seed flour but lacking some essential constituent. These results in no way suggest the presence of a poisonous substance, but rather that cotton seed flour is an adequate food when fed in a well-balanced diet and that the so-called cotton seed poisoning is due to deficiencies in the diet rather than to an active toxic substance. Later work on rats by Osborne and Mendel[5] has substantiated the results reported by the University with white rats.

The results of these experiments seem to justify the use of cotton seed flour as a part of a well-balanced diet.

Cotton Seed Flour as a Meat Substitute. Cotton seed flour is 50 per cent protein while wheat flour is 10-12 per cent protein. In its composition cotton seed flour approaches more

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[3]Wells, C. A., Ewing, P. V., Georgia Agricultural Exp. Station, Bull. 119, 1916.

[4]Richardson, A. E., and Green, H. S., J. Biol. Chem., 1916, XXV.

[5]Osborne, Thos. B. and Mendel, Lafayette B., J. Bio. Chem. 1916, XXIV.

nearly meat, whose protein content is from 12 to 20 per cent, and although it is used in mixtures as a substitute for wheat flour, it should be remembered that when using cotton seed flour the amount of meat in the diet should be cut down. In this flour we thus have a substitute both for the fast disappearing wheat flour as well as for the equally scarce meat of the diet.

Co-efficient of Digestibility. In determining the efficiency of a substance for food it is important that we determine the amount of it that is digestible, for a substance is of little account as food that cannot be well utilized by the body.

From the results of experiments on men with cotton seed meal Rather[6] found that the digestibility of the protein of cotton seed flour was 78.4 per cent. The figures for fat were not so accurate, but fat is probably quite completely digested.

To further investigate this question a series of five digestive experiments were made in the Nutrition Laboratory of the University of Texas on women. The experiment lasted five days and was divided into a two day preliminary and a three day experimental period. The diet during the five days was made up of cotton seed flour in combination with corn meal, butter, sugar and grape juice. In this diet 100 grams, about 3½ ounces, of cotton seed flour was eaten. The amounts eaten were carefully weighed and the end products of digestion were collected and analyzed. The result of this series of five experiments gave an average digestibility for the protein of cotton seed flour to be 85 per cent. The result of these experiments place cotton seed flour with other cereals and bread stuffs which according to the Atwater figure contain 85 per cent digestible protein and shows clearly the great importance of cotton seed flour as a source of vegetable protein.

Uses of Cotton Seed Flour in Cookery. The Foods Laboratory of the School of Home Economics worked out a number of satisfactory recipes for the use of cotton seed flour in cookery. The flour cannot be substituted entirely for wheat flour, but can replace to advantage one-fourth to one-third of the wheat flour in all recipes where flour is used, and thus conserve our short supply of wheat.

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[6]Rather, J. B., Texas Agric. Exp. Station., Bull. 163, 1913.

In cake mixtures it was found that the amounts of sugar could be reduced one-fourth on account of the sweetness due to sugar present in the cotton seed flour, so its use means not only a saving of wheat flour, but of sugar as well, another of our scarce and high priced foods.

COTTON SEED FLOUR RECIPES.

Cotton seed flour has a very high per cent of protein or tissue building material. It has more than twice as much protein as meat, and when used in the diet should be substituted for part of the meat.

It can replace to advantage one-fourth to one-third of the wheat flour in all recipes where flour is used, and thus conserve our rapidly decreasing supply of wheat.

Cotton seed flour breakfast food:

¼ cup cotton seed flour,
¾ cup corn meal,
⅓ teaspoon salt,
4 cups boiling water.

Mix flour and corn meal together. Stir this into boiling salted water. Allow to boil for ten minutes, stirring constantly. Cook over boiling water for forty minutes. This may be served with cream and sugar, or moulded in pans one inch deep. When cool cut in squares, roll in crumbs and brown in fat.

Baking powder biscuit:

⅔ cup cottonseed flour,
1⅓ cup wheat flour,
2 tablespoons Wesson oil,
½ teaspoon salt,
¾ cup milk.

Add the oil to the milk, and stir into the flour into which the salt and baking powder have been sifted.

Muffins:

3 tablespoons Wesson oil,
¼ cup sugar,
1 egg,
¾ cup milk,
1½ cup flour,
½ cup cotton seed flour,
4 teaspoons baking powder.

Add the oil, sugar and beaten eggs to the milk. Beat the milk into the flour and baking powder. Bake in gem pans or in sheets, and cut in squares.

Boston brown bread:

1 cup corn meal,
1 cup graham flour,
1 cup cotton seed flour,
1 cup molasses,
1½ cup sour milk,
1 teaspoon soda,
½ teaspoon salt.

Sift soda and salt with the cotton seed flour. Add molasses to the sour milk and stir the dry ingredients into the liquid. Fill buttered pound baking powder tins ⅔ full. Tie buttered lid down firmly. Steam for three hours. An additional cup of corn meal may be used in place of the graham flour.

Light bread:

1 cup buttermilk,
1 tablespoon fat,
½ tablespoon sugar,
3 cups white flour,
1 cup cotton seed flour,
1½ teaspoon salt,
¼ Fleischman's yeast cake,
2 tablespoons water.

Make a sponge of the buttermilk, fat, sugar, 2 cups of flour, and the ¼ yeast cake softened with 2 tablespoons of cold water. When this sponge has doubled in bulk, add the remaining flour until stiff enough to knead. Knead until it no longer sticks to the board. Set to rise. When doubled in bulk form into a loaf and bake. This bread may be made with water or sweet milk. The acid buttermilk, it is thought, gives a more tender loaf. It is best to use more yeast with cotton seed flour bread than with wheat flour bread.

Luncheon rolls:

Add one tablespoon sugar and one tablespoon butter to the above recipe when making stiff. When it has doubled in bulk roll to about ¼ of an inch in thickness. Cut with a biscuit cutter. Make into pairs by brushing one lightly with butter or other fat, and placing another on top. When they have doubled in bulk place in a very hot oven.

USES FOR COTTON SEED FLOUR BREAD CRUMBS.

English pea loaf:

1 cup pea pulp,
¼ cup chopped onion,
¼ cup chopped nuts,
1 egg,
Salt and sage,
Toasted cotton seed flour bread crumbs,
1 tablespoon Wesson oil.

Brown onions in oil, add to beans, nuts, and eggs, thicken with bread crumbs. Place in buttered pan and bake about forty-five minutes. Serve with tomato sauce.

Potato and nut loaf:

1 large raw potato or 2½ cups cooked rice,
1 cup chopped nuts,
1½ cup cotton seed bread crumbs,
2 eggs,
1 small onion,
1 cup hot water,
Salt,
1 pint strained tomatoes.
2 tablespoons butterine, Wesson or peanut oil.

Grind the nuts, onions, and raw potatoes together, add the hot water and crumbs. Pour the tomato juice over it, and baste as it bakes.

Navy bean croquettes:

½ cup chopped nuts,
¼ cup cotton seed flour bread crumbs,
2 eggs,
1 teaspoon lemon juice, salt, and cayenne pepper,
1 cup bean pulp.

Mix well, shape into croquettes, roll in bread crumbs, in egg beaten with one tablespoon of water to each egg, and again in crumbs. Brown in fat. The bread crumbs may be made from bread in which one-fourth of the flour is from cotton seed. The color is not so beautiful, however, as when white flour is used.

Split pea croquettes:

1 cup pea pulp,
1 egg,
6 tablespoons cotton seed bread crumbs,
2 tablespoons chopped onion,
1 teaspoon chopped parsley,
Few brains cayenne pepper, thyme, salt and baking powder.

California bean croquettes:

1 cup bean pulp,
1 tablespoon cotton seed bread crumbs,
1 tablespoon finely chopped onion,
2 tablespoons egg,
Few grains cayenne pepper, salt and baking powder.

Scrapple:

Cook scrap meat until tender, and grind. To ⅔ cup meat, ⅓ cup of cotton seed flour and ⅔ cup corn meal, add 3 cups of water, ⅔ teaspoon salt and one small onion chopped fine. Cook in a double boiler thirty minutes. This may be browned in a skillet, or when the mush is cold it may be molded into a loaf, basted with tomato juice and baked. It should be served with a tomato sauce. If a meat broth is used instead of water the corn meal and cotton seed flour may be doubled without increasing the quantity of meat. The meat is really used for flavoring.

Rolled Wafers:

¼ cup butterine,
6 tablespoons powdered sugar,
½ teaspoon vanilla,
Few grains of salt,
¼ cup cream,
9 tablespoons flour,
5 tablespoons cotton seed flour.

Add cream drop by drop to the creamed butter and sugar, then add flour, flavoring and salt. Spread very thin over buttered bottom of inverted pan. Mark in squares and bake in a hot oven. Separate squares and roll. This may be sprinkled with chopped nuts before baking. (Make thirty wafers.)

Eggless cake:

¾ cup sugar,
½ cup butter
1 cup sour milk,
1⅓ cup flour,
⅔ cup cotton seed flour,
1 cup chopped raisins,
1 teaspoon soda,
1 teaspoon cinnamon,
½ teaspoon cloves,
1 teaspoon lemon extract.

Mix and sift the dry ingredients. Add alternately with milk, to the creamed butter and sugar. Bake in a moderate oven for an hour.

Pie Crust:

⅓ cup fat,
1 cup cotton seed flour,
⅔ cup white flour,
⅓ teaspoon salt,
Ice water.

Cut in half fat and roll in half. Cool well before baking.

Cheese straws:

Excellent cheese straws are made by rolling into the paste made from the pie crust recipe ⅓ cup of cheese. Roll one-eighth of an inch thick, and cut in strips about three inches long. Place these straws on the inverted bottom of a biscuit pan and bake until crisp.